NA-AL-RICH CHONDRULES: DROPLETS PRODUCED BY INCIPIENT SHOCK-MELTING? Alex Ruzicka, Gregory A. Snyder, and Lawrence A. Taylor. Planetary Geosciences Institute, Dept. Geological Sciences, University of Tennessee, Knoxville, TN, 37996.

Na-Al-rich chondrules are a chemically distinctive suite of chondrules found in ordinary chondrites [1, 2]. They form a subset of Al-rich chondrules that also include Na-Al-Ca-rich, Na-Al-Cr-rich, and Ca-Al-rich varieties [1, 2]. It has been proposed that Al-rich chondrules were produced by the impact-induced, collisional separation of the molten mesostases of chondrules [3]. Instead, based on compositional similarities between Na-Al-rich chondrules and melt pocket glasses, we suggest that Na-Al-rich chondrules formed by the incipient shock-melting of chondritic material. Melt pockets are glassy regions in chondrites that were produced by localized, shock-induced melting [4-6]. They often contain insets of olivine, chromite, metal, and troilite [4, 5]. Most of the olivine grains in melt pockets appear to have been derived from the host rock in an unmelted state [4, 5].

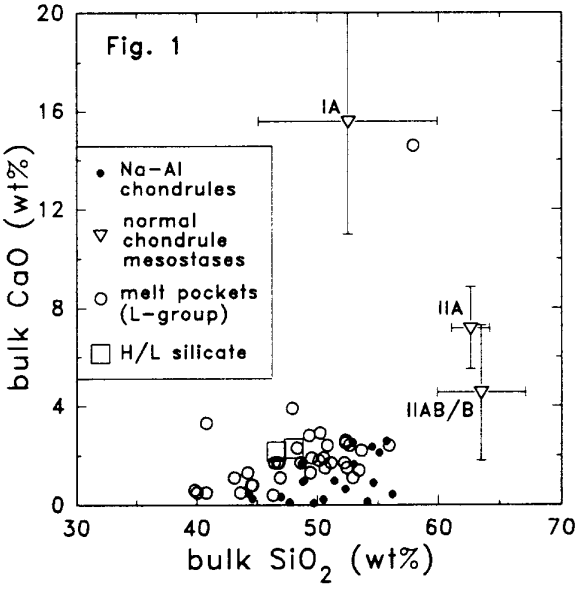
Ca-Si (Fig. 1). Although the major-element compositions of Na-Al-rich chondrules and chondrule mesostases are similar in most respects, the latter tend to be enriched in SiO_2 or CaO (Fig 1; data sources: [1, 5, 8-12]). This suggests that Na-Al-rich chondrules do not represent chemically unmodified samples of the mesostases of typical ferromagnesian chondrules. In contrast, the SiO_2 and CaO contents of melt-pocket glasses and Na-Al-rich chondrules overlap substantially, although on average, the former have a slightly higher Ca/Si ratio (Fig. 1).

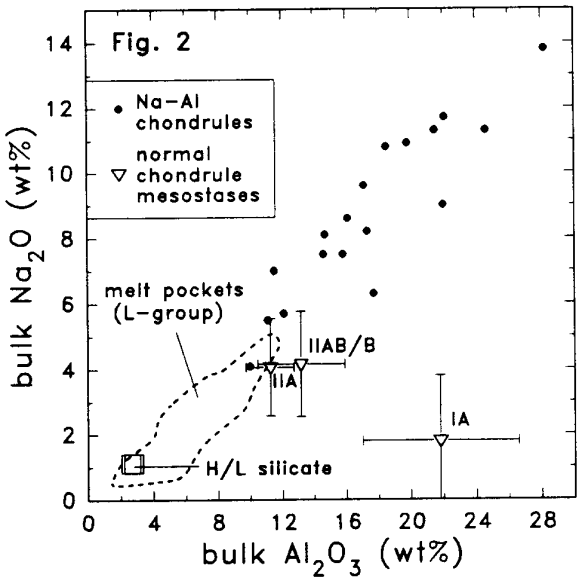
Na-Al (Fig. 2). The hallmark of Na-Al-rich chondrules is their enrichment in Na and Al relative to typical chondrules and the silicate fraction of chondrites. Bischoff and Keil [1, 2] arbitrarily considered only Na-rich objects with ≥10 wt% Al_2O_3 to be Na-Al-rich chondrules, but noted that similar objects with lower Al contents are also present in chondrites. Relative to H- and L-group chondrite silicate (and most chondrules), melt-pocket glasses are also enriched in Na and Al [5] (Fig. 2; data sources same as for Fig. 1).

As Fig. 1 includes only those Na-Al-rich chondrules with ≥10 wt% Al_2O_3 and as Na and Al covary in identical fashion for Na-Al-rich chondrules and melt-pocket glasses, it seems likely that the Na and Al contents of these two types of objects overlap considerably.

Normative compositions (Fig. 3). Melt pockets are depleted in normative olivine (MgO, FeO) compared to H- and L-group silicate [4, 5], and have compositions that scatter about an olivine-variation trend passing through mean H- and L-group silicate (Fig. 3; data sources the same as for Fig. 1). The normative compositions of Na-Al-rich chondrules scatter, but appear to lie on an olivine-poor, orthopyroxene-poor, and feldspar-rich extension of the trend shown by melt-pocket glasses (Fig. 3).

Interpretation. The major-element compositions of Na-Al-rich chondrules and melt-pocket glasses are distinctive from chondrites and typical ferromagnesian chondrules, yet generally similar to one another, suggesting that both formed by similar processes. Melt pockets clearly formed by the localized, shock-induced melting of chondrites, and the same may have been true for Na-Al-rich chondrules. However, the two types of objects differ in their overall form (droplets *vs.* dispersed masses), and they show systematic differences in their compositions. The normative compositions of melt-pocket glasses (Fig. 3) are suggestive of incomplete melting of olivine during incipient impact-melting of chondrites. The normative compositions of Na-Al-rich chondrules (Fig. 3) can be explained by the incomplete melting of *both* olivine and orthopyroxene during impact-melting of chondritic material. The slightly lower Ca/Si ratio of Na-Al-rich chondrules compared to melt pockets (Fig. 1) is consistent with the idea that less Ca-bearing pyroxene would have had to melt to form Na-Al-rich chondrules than to form melt-pocket





glasses. The chemical differences between Na-Al-rich chondrules and melt-pocket glasses are generally consistent with the relative melting points of feldspar, pyroxene, and olivine in shock experiments [6], and suggest that *Na-Al-rich chondrules formed by a lower degree of impact-induced partial melting of chondritic material than that which formed melt pockets.* Such low-degree melts may have separated from chondritic material as a spray during the initial stages of an impact event, possibly in a process analogous to jetting [7].

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